

6 OPERATIONS STRATEGY

The *Interim Phase II Remedial Action Report* for OU 7-08 (INEEL 1999) listed several activities to be conducted during Phase II. The status of each of these activities is addressed in Section 6.1. Planned and proposed future activities are addressed in Section 6.2.

6.1 Status of Interim Phase II Activities

The following activities were to be conducted during Phase II according to the *Interim Phase II Remedial Action Report* (INEEL 1999):

- Volatile organic compound release and transport modeling
- Flux chamber monitoring
- Volatile organic compound inventory investigation
- Subsurface Disposal Area and Transuranic Storage Area drilling and sampling
- Long-term treatment scenarios
- New unit procurement
- Well rehabilitation and microbial analysis of samples from Wells 3E, 4E, and 3V.

The status or outcome of these activities is discussed in the following subsections.

6.1.1 Volatile Organic Compound Release and Transport Modeling

There has not been any VOC transport modeling performed since that reported in the *Phase II Remedial Action Report* (INEEL 1999). Plans have been made to update the model during FY 2003 (see Section 6.2.5).

6.1.2 Flux Chamber Monitoring

The increase in the VOC inventory put forth by Miller and Varvel (2001) made it necessary to make a more proper accounting of the mass of contamination being released from the waste through the overburden into the atmosphere. To help quantify the atmospheric release, a flux chamber system designed to automatically monitor carbon dioxide flux was used to determine the tortuosity of the surface soil. In the VOC transport model, the tortuosity governs the diffusive flux of contaminants through the soil and ultimately the release of contaminants to the atmosphere. Carbon dioxide was monitored because the flux chamber already was set up to analyze carbon dioxide and because the pits are a source of carbon dioxide. The flux chamber was placed at four locations for a period of 1 month each and reported data every 10 minutes to a data logger.

Results of the flux chamber monitoring are documented in Varvel and Sondrup (2001). The tortuosity values estimated by the study (2.8–4.6) were consistent with existing theoretical and empirical relations (2.5–4.6). The estimated values were also smaller than those used in previous modeling efforts. However, the large tortuosity factors used in previous modeling studies were likely compensating for an underestimated source inventory. The data provided by this study will be used in future modeling work.

6.1.3 Volatile Organic Compound Inventory Investigation

The carbon tetrachloride inventory estimate has changed as new information and data has emerged. The history of the inventory estimates and an explanation for each change is contained in Table 6-1. Figure 6-1 provides a graphical representation of the historical estimates of carbon tetrachloride inventory.

Table 6-1. Carbon tetrachloride inventory history.

Estimate Source	Estimate Mass (kg)	Description
Kudera 1987	1.5E+05	Used for the OCVZ RI/FS (Duncan, Troutman, and Sondrup 1993).
HDT (LMITCO 1995)	1.13E+05	Reduced the Kudera estimate by 25% to account for possible evaporation of the volatile components during waste processing and storage. Kudera (1987) estimate listed as upper bound.
IRA (Becker et al. 1998)	2.26E+05	IRA modeling indicated the HDT inventory estimate was probably low. The inventory estimate was arbitrarily doubled (2x) to get the IRA fate and transport model to calibrate.
Miller and Navratil (1998)	4.9E+05 kg	Monthly rather than yearly shipping records were reviewed, and inconsistencies in the records were identified. Assumptions were made to resolve inconsistencies with Kudera (1987).
Miller and Varvel (2001)	8.20E+05 kg	Used new sources of information that became available following inquiries made during the Miller and Navratil (1998) investigation.

HDT = historical data task
IRA = interim risk assessment
OCVZ = organic contamination in the vadose zone
RI/FS = remedial investigation and feasibility study

Miller and Varvel (2001) provided the final estimate of carbon tetrachloride and total VOC inventory. Miller and Varvel (2001) identified new sources of information based on inquiries initiated as a result of the Miller and Navratil (1998) report. The new information from the Rocky Flats Plant included waste disposal sheets, the Organic Waste Treatment Plant Logbook, and details related to processing of drums from the 903-series area. This information allowed an accurate count of the 743-series drums, an accurate reconstruction of drum burial locations by pit, and provided a defensible means to estimate carbon tetrachloride and total VOC mass buried in the SDA. This final estimate of carbon tetrachloride and total VOC mass buried in the SDA is shown in Table 6-2. A map of the 743-series waste drum burial locations is shown in Figure 5-1. Complete details of the inventory investigation are documented in *Reconstructing the Past Disposal of 743-Series Waste in the Subsurface Disposal Area for Operable Unit 7-08, Organic Contamination in the Vadose Zone* (Miller and Varvel 2001).

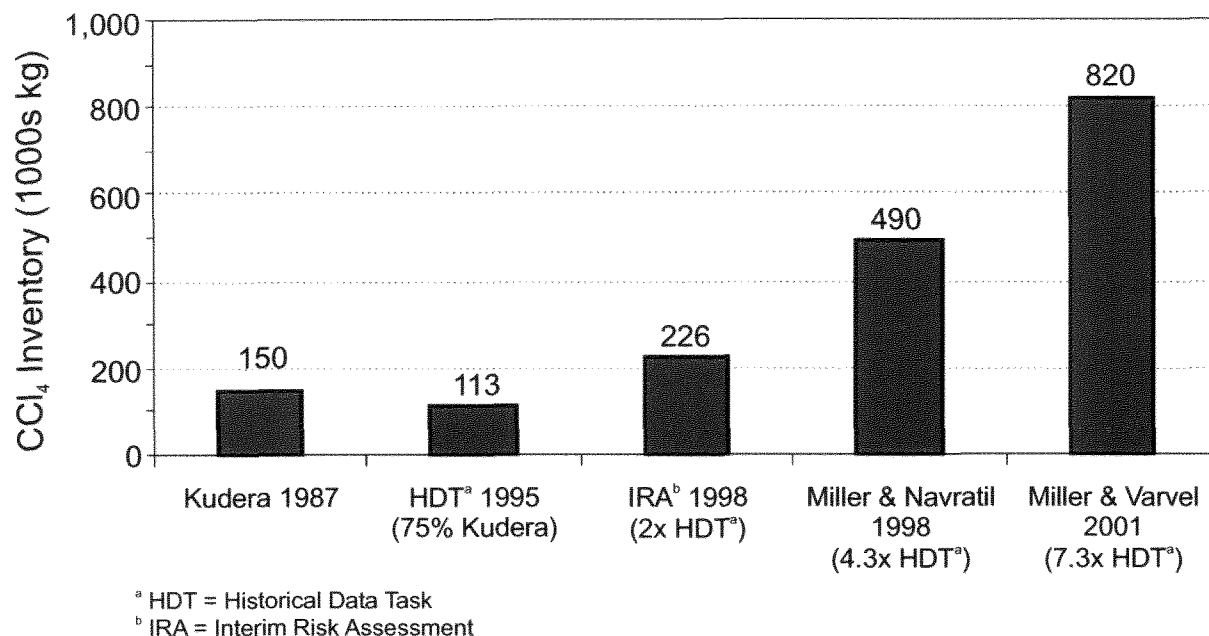


Figure 6-1. Historical carbon tetrachloride inventory estimates.

Table 6-2. Final estimate of initial volatile organic compound inventory.

Constituent	Mass (kg)
Carbon tetrachloride	8.2E + 05 (± 1.4E + 05)
Total volatile organic compounds	1.1E + 06 (± 2.0E + 05)

Varvel (2001) estimated the amount of non-carbon tetrachloride VOCs in the 743-series waste by assuming the non-carbon tetrachloride fraction reported by Miller and Varvel (2001) was made up of equal volumes of tetrachloroethene; trichloroethene; and 1,1,1-trichloroethane. Based on this assumption, Varvel (2001) estimated the original inventory to be as shown in Table 6-3.

Table 6-3. Estimated non-carbon tetrachloride volatile organic compound inventory.

Constituent	Mass (kg)
Tetrachloroethene	9.8E + 04
Trichloroethene	8.9E + 04
1,1,1-trichloroethane	8.1E + 04

Because of the comprehensive and detailed nature of the Miller and Varvel (2001) investigation, the OCVZ Project does not anticipate further investigations into the carbon tetrachloride inventory estimate and considers the Miller and Varvel (2001) estimate to be final. The estimates of non-carbon tetrachloride VOCs in the 743-series waste put forth by Varvel (2001) will also be considered final.

6.1.4 Subsurface Disposal Area and Transuranic Storage Area Drilling and Sampling

In 1999 and 2000, OU 7-13/14 drilled 12 wells inside the SDA and Transuranic Storage Area. Ten wells were drilled to either the B-C interbed (34 m [110 ft]) or the C-D interbed (73 m [240 ft]) and instrumented with tensiometers and lysimeters. The other two wells were drilled below the C-D interbed and instrumented with vapor ports. These two wells were drilled close to each other immediately north of the junction of Pits 4 and 6. One of the wells (M17S) was drilled into the aquifer to 203 m (665 ft) below land surface and completed as an aquifer-monitoring well. A vapor port was installed in Well M17S at 174 m (570 ft) below land surface just above the water table. The other well, DE-1, was drilled to 133 m (435 ft) below land surface and contains four vapor ports at 89, 105, 114, and 121 m (292, 343, 375, and 396 ft) below land surface and also contains an open interval from 75 to 82 m (245 to 270 ft) below land surface for vapor extraction.

Figure 6-2 shows carbon tetrachloride vapor concentration measurements in Wells DE-1 and M17S below the C-D interbed (73 m [240 ft]). The concentrations range from 0.1 to 12 ppmv, but most of the measurements are less than 6 ppmv. These concentrations are lower than expected since carbon tetrachloride concentrations in the deep vadose zone in Well M10S (outside the SDA) have been higher. Concentration data from other locations in the deep vadose zone below the SDA are necessary to confirm the data from the location of Wells DE-1 and M17S. Section 6.2.2 discusses plans to drill an additional five deep monitoring and extraction wells inside the SDA.

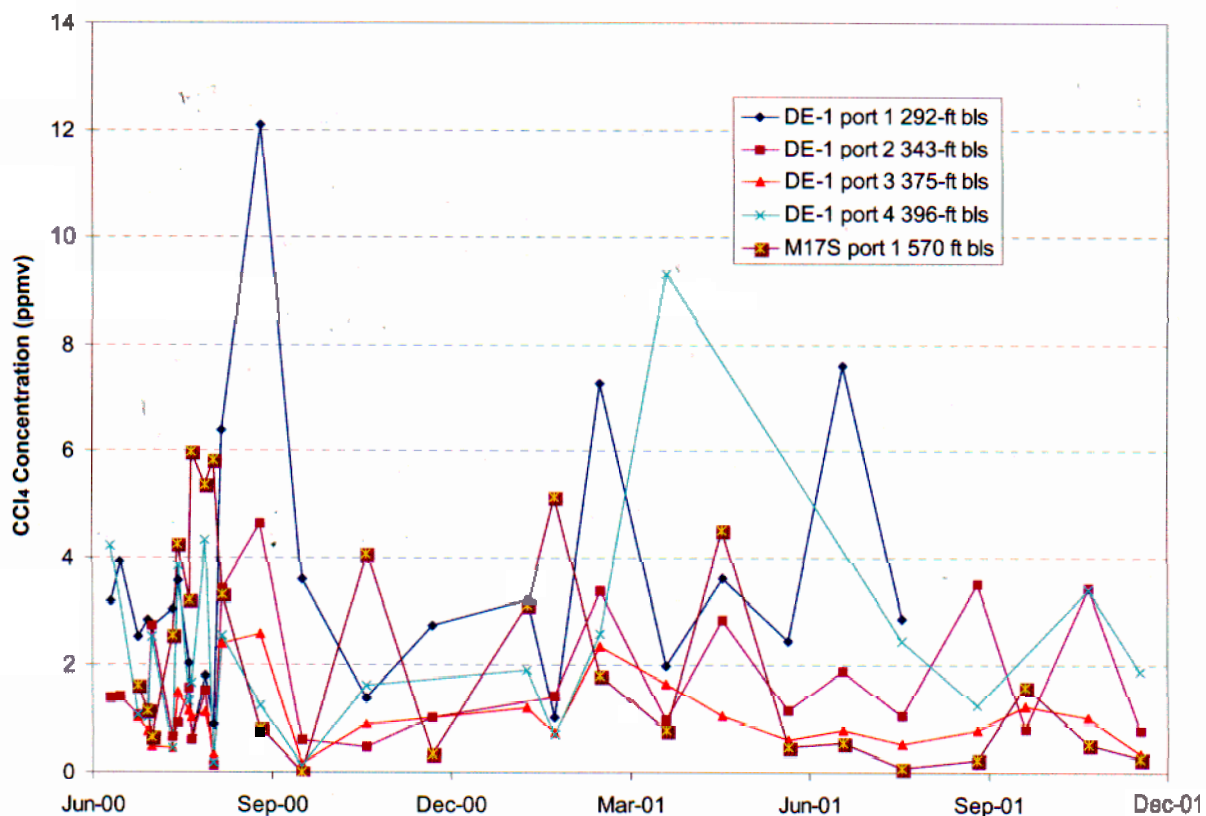


Figure 6-2. Carbon tetrachloride vapor concentrations in Wells DE-1 and M17S.

6.1.5 New Unit Procurement

A catalytic oxidation system was purchased from King Buck Technology of San Diego, California. This system, designated as Unit D, was installed at the SDA and tested following TPR-1764, "VVET Catalytic Unit Integrated Test," which is a nonactive document used for reference only. Project documentation, including safety analysis, testing and operating procedures, and a technician qualification program, has been developed, reviewed, approved, and released for use. The DOE, IDEQ, and EPA conducted a prefinal inspection before full-scale operation began. The Prefinal Inspection Checklist for VVET Unit D and notification of completion of the inspection are included in Appendix B.

6.1.6 Status on Well Remedy and Microbial Analysis of Samples Extracted from Wells 3E, 4E, and 3V

Operable Unit 7-08 extraction and monitoring Wells 3E, 4E, and 3V were installed in 1994. Extraction Well 4E became plugged after approximately 2 years of operation while connected to Units A and C. Extraction Well 3E was connected to Unit B along with extraction Well 2E, and because initial operations did not include flow instrumentation at the well head, it is difficult to determine when Well 3E became plugged. However, discussions with technicians in charge of operations at the time indicate that Well 3E probably became plugged shortly after the start of operations in 1996. Monitoring Well 3V became plugged immediately after an attempt to extract from the well.

Video logs taken in 1999 indicate that a viscous black liquid was present on the internal surface of the well casings near the extraction zones. Samples were taken of the black substance in 1999 and analyzed for microbic enrichment. Laboratory tests were performed in 2000 and 2001. A discussion of the microbic analyses and the results is included in Appendix A. Initial enrichments of the well material showed the presence of a high density of microbes as well as the presence of iron-reducing bacteria. The study indicates that bentonite, used in the construction of the wells, acted as a source of iron-reducing bacteria. Recommended remediation options originally included removing the screened interval to remove the plugging material, flooding of the well with a hypochlorite or mildly acidic solution to dissolve the plugging material, or filling the well with concrete and drilling a new extraction well designed with preventive measures against microbic growth.

The decision was made to remove the screened interval sections of the wells by reaming with an oversized bit. The screened sections on Wells 4E and 3V were reamed in early 2000. Unit A was then hooked up to Well 4E after reaming, but efforts to extract subsurface vapors were unsuccessful. During the reaming of Well 3V, the bit became tangled with the vapor port tubing after reaming the upper screen and advancing to the lower screen. The bit was eventually lost, but the procedure did manage to ream a length approximately 24 m (80 ft) long. Unit B was temporarily connected to Well 3V after the reaming and initial extraction testing was unsuccessful. A second attempt at vapor extraction was made in 2002 but was again unsuccessful. Reaming Well 3E has not been attempted because of the lack of success with the other two wells. Well 3E, which was not reamed, was also tested for flow in 2002 and the well still appears to be plugged.

Because of the problems with microbial growth in the screened intervals, future wells will be constructed using an open well design where screened casing is not installed. Section 6.2.2 discusses plans to drill additional monitoring and extraction wells inside the SDA.

6.1.7 Status of Other Activities Performed not in the Interim Phase II Remedial Action Report

Since the last RA report in 1999, progress has been made on other important activities not listed in the 1999 Interim Remedial Action report. These are discussed briefly in the following subsections.

6.1.7.1 Soil-Gas Surveys. Organic contamination in the vadose zone project and agency personnel proposed in the OCVZ DQO report (INEEL 2002) to track traits and trends in residual VOC release through transient observations of shallow soil gas. Shallow soil-gas measurements were to be taken over the following three primary areas known to contain the largest amounts of VOCs: (1) the west end of Pit 10, (2) the east end of Pit 4 near the northern junction with Pit 6, and (3) the southern end of Pit 9. Shipping and disposal records indicate that nearly all of the VOC sludge was buried in these locations. Figure 6-3 shows the results of a soil-gas survey performed in 2000 that confirms the burial location data shown in Figure 5-1. Pit 9 was not included in the survey because other work was being performed there at the time.

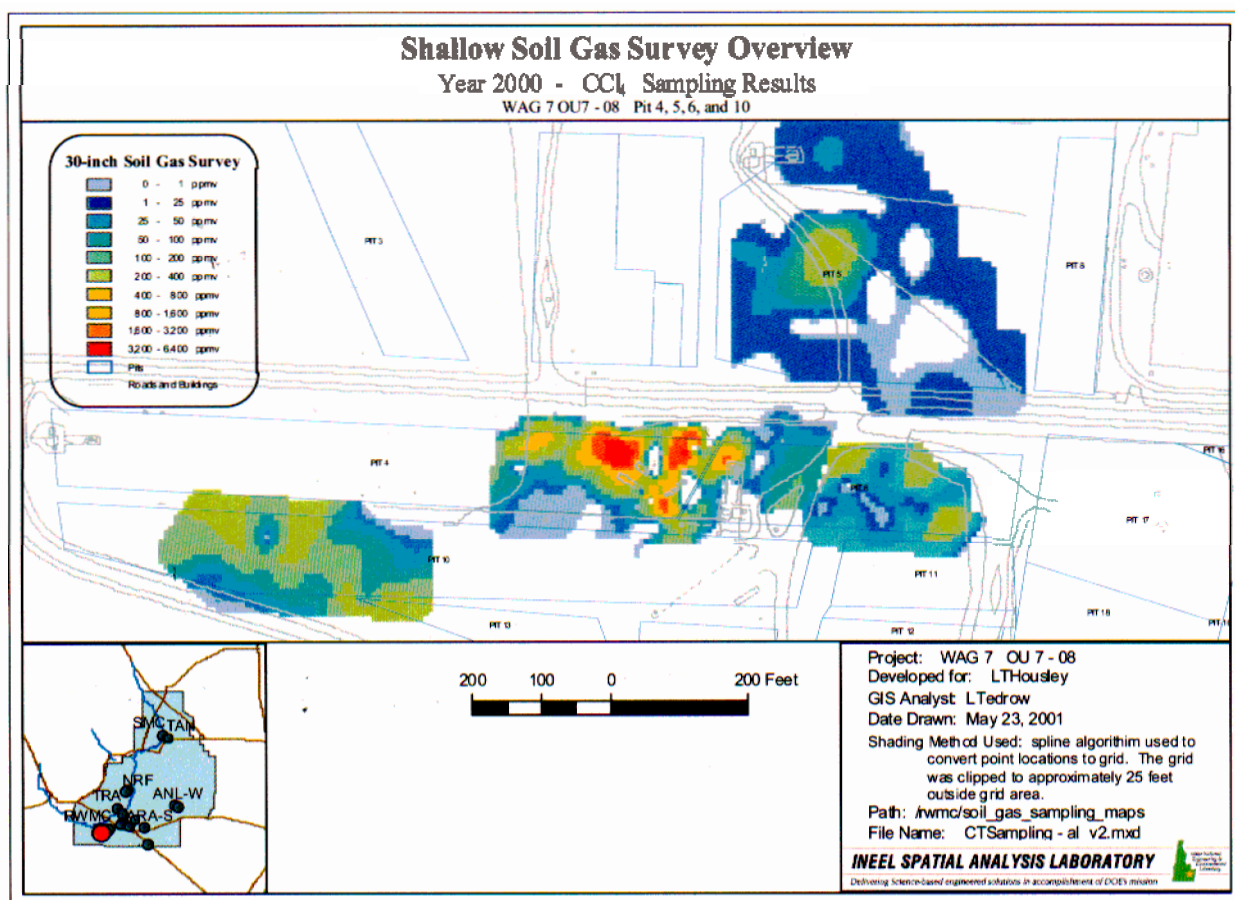


Figure 6-3. Shallow soil-gas survey results in 2000.

Initially, a quarterly sampling frequency was suggested by the project and accepted by the DQO team. However, because this frequency would likely be dominated by weather and seasonal variations, a lower sampling frequency was adopted, and sampling will be changed to annual or biannual over a several-year period in the revised OCVZ DQO report (INEEL 2002). However, probes have recently been installed in the waste zone of areas containing 743-series waste (see Footnote C), and this data may yield the information that the soil-gas surveys were to provide. Some of the probes are capable of taking a vapor sample from the waste zone, and other probes can be logged with an instrument to yield the chlorine content in the waste. The chlorine content has been used to estimate the mass of VOCs remaining in the pit (see Section 6.1.7.2). The need and schedule for similar soil-gas surveys in the future will be based on sampling of the vapor probes.

Operable Unit 7-08 also performed two soil-gas surveys in 2001 (Housley, Sondrup, and Varvel 2002). The first was a shallow soil-gas survey over Pit 2 to determine if Pit 2 was a significant source of VOCs and carbon tetrachloride, and the second was a shallow soil-gas survey performed along a transect in the east end of Pit 4 to determine the impact, if any, of probe installation on the release of VOCs. The survey over Pit 2 demonstrated that Pit 2 was not a significant source of VOCs. The results of the second survey were inconclusive. Future shallow soil-gas surveys such as these will not be repeated unless additional disposal records are identified that indicate additional source areas may be present or as further source release rate determinations become necessary.

6.1.7.2 Residual Volatile Organic Compound Mass Estimate. The OCVZ Project considers the residual VOC source mass a critical element in making predictions of future risk and required cleanup times. When the original OCVZ DQO report was written, no estimate for the amount of VOCs remaining in the pits was included. However, a recent study provided a preliminary estimate of the mass of carbon tetrachloride and total VOCs remaining in the SDA pits (see Footnote B). The estimate is based on calculations of carbon tetrachloride and total VOC mass originally buried (Miller and Varvel 2001) and the results of recent chlorine logging in the waste. The chlorine logging was performed in probeholes laid out in a transect through 743-series waste in Pit 4. Chlorine logging provides the basis for estimating the current mass of carbon tetrachloride and total VOCs at select locations in the SDA. The study attempted to quantify and propagate random errors in both data sets to provide an estimate of the uncertainty in the final VOC mass estimate.

The results of the study estimate that 51% ($\pm 20\%$) of the initial chlorine mass buried in the SDA still remains. If it is assumed that the VOCs have not undergone chemical transformation since burial and that the relative mass fractions of each VOC in 743-series waste has remained constant, the mass of carbon tetrachloride remaining in the pits is estimated to be $4.1\text{E}+05$ kg with a standard error of $1.5\text{E}+05$ kg. The mass of total VOCs remaining is estimated to be $5.5\text{E}+05$ kg with a standard error of $2.0\text{E}+05$ kg. The study points out that additional work is needed to determine the adequacy of the assumptions and the presence of any bias errors in the supporting analysis, both of which influence the accuracy of the remaining mass estimates.

The mass of VOCs estimated to remain in the pits is relatively large and, depending on the release rate, the source could be active for many years. Therefore, it is recommended that chlorine logging of the probeholes be continued on a regular basis to track trends in release rate. Efforts to improve the accuracy of the chlorine logging, such as a better calibration for the instrument, are also recommended.

6.2 Proposed Future Activities for Phase II

The following sections identify activities that are planned or proposed for the next stage of Phase II.

6.2.1 Replacement of Recuperative Flameless Thermal Oxidizer Units with Catalytic Oxidizer Units

Currently, three VVET units are in operation: two thermal oxidizers (designated as Units A and B) and one catalytic oxidizer (designated as Unit D). The thermal oxidizer units will be replaced with catalytic units in FY 2003 because the thermal units are nearing the end of the recommended replacement period (7 years) and because they have been plagued with operational problems resulting in less than desired operating performance. In addition, thermal oxidizer Units A and B were designed to extract and treat vapors from two extraction wells each while the catalytic oxidizer (Unit D) is designed to extract and treat vapors from up to four extraction wells. As additional extraction wells are drilled (see Section 6.2.2), it will be beneficial to connect multiple wells to a single unit.

6.2.2 Installation of New Monitoring and Extraction Wells

Operable Unit 7-08 plans to drill 15 new vapor monitoring and extraction wells in the SDA in FY 2002 and FY 2003. The locations of the wells are shown in Figure 6-4. Plans call for a cluster of three wells in each of five locations. One of the wells in each cluster will have a shallow extraction interval, one well will have an intermediate extraction interval, and the third well in the cluster will have a deep extraction interval. The shallow extraction interval is located above the B-C interbed (34 m [110 ft]). The intermediate extraction interval is located between the B-C interbed (34 m [110 ft]) and the C-D interbed (73 m [240 ft]), and the deep extraction interval is located below the C-D interbed (73 m [240 ft]). The intermediate well will have vapor monitoring ports in the shallow zone, and the deep wells will have vapor monitoring ports in the intermediate and deep zone. The five locations for the clusters were chosen based first on proximity to waste and second on accessibility.

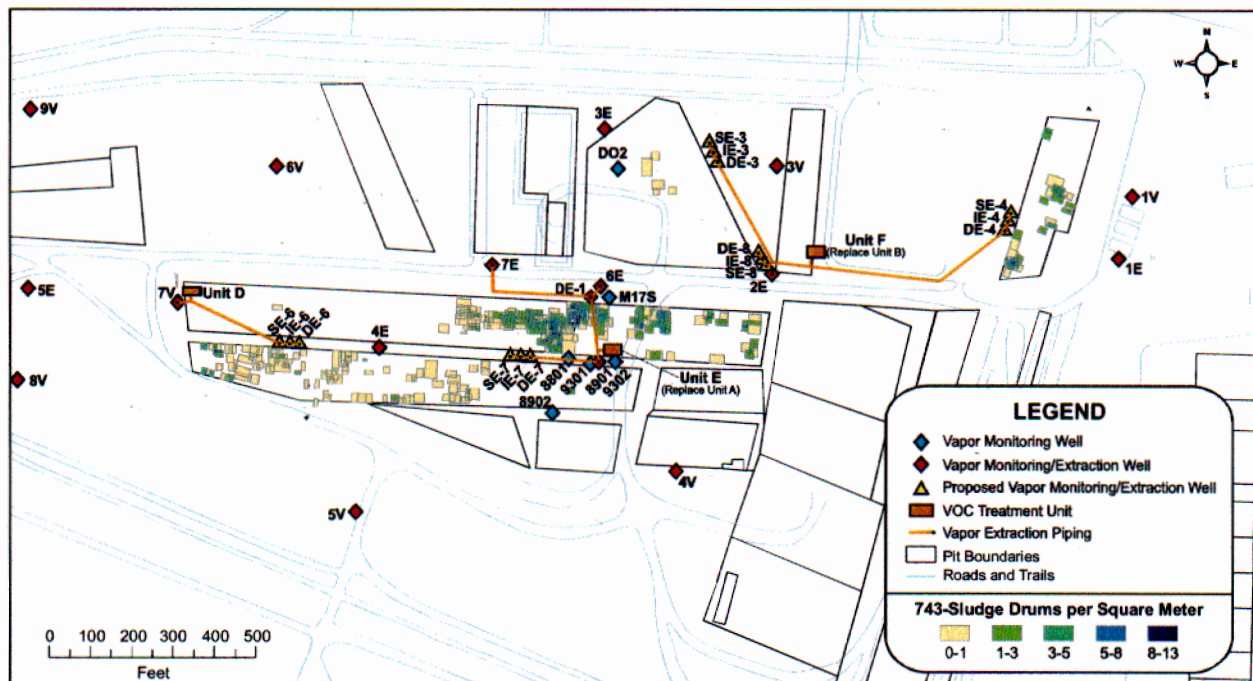


Figure 6-4. Locations of new monitoring and extraction wells and proposed vapor vacuum extraction with treatment system design.

Note: Units E and F have not been installed but will replace Units A and B. Units E and F and are shown in their proposed locations.

The new wells will provide valuable monitoring data in important areas where there is little or no data (e.g., near Pit 9 and below the C-D interbed [73 m {240 ft}]). The wells will also provide the OCVZ Project with much needed extraction wells in key locations. Most of the existing OCVZ extraction wells are not in the best locations and their slotted polyvinyl chloride screens make them prone to plugging by microbial growth (see Section 6.1.6). The new extraction wells, placed in more strategic locations, will provide the project with much more flexibility to improve mass removal and extraction efficiency. These new wells will also have open intervals (similar to Well 8901) to avoiding the plugging problem, and the intervals will be longer than the slotted screens. Details on the well construction design can be found in the Statement of Work (Casper 2002).

The VVET operation will benefit from having additional wells available to each VVET unit, which can be used on a rotating basis. Figure 6-4 shows the wells that may be connected to each of the units. As the concentration in one well is drawn down rather than continuing to pump low concentration vapor, or shutting down the unit waiting for concentrations to rebound, the unit would be switched to a different well where the concentrations were higher. Alternatively, since up to four wells can be connected to the new catalytic oxidizer, simultaneous extraction from a shallow, intermediate, and deep well can be accomplished. Deep extraction is discussed in more detail in Section 6.2.3.

As the wells are drilled, they will be added to the sampling schedule outlined in the revised OCVZ DQO report (INEEL 2002).

6.2.3 Deep Vadose Zone Vapor Monitoring and Extraction

Five of the 15 new wells to be installed in FY 2002 and FY 2003 will have monitoring and extraction capability below the C-D interbed (73 m [240 ft]). Vapor monitoring data from these wells will be used to determine if extraction is necessary from the deep vadose zone. Results from a modeling study by Sondrup (1998) suggest that the current soil-vapor extraction system may be incapable of preventing future groundwater contamination above current safe drinking water standards because of contamination in the deep vadose zone that is not being impacted by shallow extraction. However, vapor concentration data obtained from a single location in the deep vadose zone since that modeling was performed suggest that the amount of deep contamination may be less than assumed in the model (see Section 6.1.4). Additional data from other deep locations are needed to make a comprehensive analysis.

After the new wells are drilled, they will be sampled according to the schedule contained in the revised DQO report (INEEL 2002). However, the accuracy of the current instrument used to sample and analyze the vapor, the Brüel and Kjaer Photoacoustic Gas Analyzer, is suspect at the low concentrations (e.g., < 20 ppmv). If the results from the new wells are also low, then a more accurate instrument may be needed to confirm the concentrations and determine if extraction is necessary. If it turns out that the concentrations from the other locations are low, then the conceptual model of transport in the deep vadose zone may have to be revised. If the data show that extraction is necessary, the deep wells can be used as extraction wells. However, they will likely have to be used in conjunction with the shallow wells in the same location to avoid pulling contamination deeper.

6.2.4 Oxidizer Emissions Monitoring

Operable Unit 7-08 is currently pursuing procurement of an apparatus to facilitate periodic sampling of oxidizer emissions as specified in the OCVZ *Operations and Maintenance Plan* (McMurtrey and Harvego 2001). This equipment will be capable of detecting volatile organic and inorganic hazardous air pollutants at sub-ppmv levels and will be portable so that each of the three oxidation units can be tested. Procurement of a suitable analysis system is planned for early FY 2003 with oxidizer testing to follow later in the fiscal year. The planned off-gas testing is anticipated to provide needed insight into the performance of the respective oxidation systems and allow for optimization of oxidizer operating

parameters without sacrifice of contaminant destruction efficiency. Monitoring is planned for FY 2003 and will be repeated thereafter following significant system modification.

6.2.5 Volatile Organic Compound Transport Modeling

The most recent modeling studies of VOC transport are more than 4 years old (Magnuson and Sondrup 1998; and Sondrup 1998). The model will be updated in FY 2003 with data and information obtained during the past 4 years including a revised VOC inventory; a residual VOC mass estimate; new release rate and transport model parameters; and 4 additional years of vadose zone vapor concentration data, groundwater concentration data, and mass removal data.

After the model is updated and recalibrated using the new data, it will be used to develop new preliminary remediation goals for the project. The original preliminary remediation goals have not been updated since they were published in the OU 7-08 ROD (DOE-ID 1994).

6.2.6 Volatile Organic Compound Mass Remaining in the Pits and Release Rate Trends

An attempt to estimate the remaining mass has been made using chlorine logging data and disposal records (see Section 6.1.7.2). However, the uncertainty of the estimate was rather high and was based on data from one location (743 Focus Area in the east end of Pit 4). This estimate can be improved by analysis of chlorine logging data from other focus areas with waste probes, improvement of the chlorine calibration of the logging instrument, and sampling and analysis of 743-series waste sludge from the pits as part of the Glovebox Excavator Method Project (Salomon et al. 2003). In addition to the remaining mass, it is also important to know the trend in release rate so the life of the remaining source can be estimated.

Currently, no plans have been made to estimate remaining VOC mass at the other two focus areas where Type A probeholes are installed. However, OU 7-13/14 plans to continue logging all the probeholes and possibly improve the chlorine calibration of the instrument. Continued logging will help detect trends in remaining mass and release rate. The data will be available if it is considered constructive to improve upon the analysis of Miller, Sondrup, and Josten (see Footnote B). In addition, regular sampling of soil-vapor probes by OU 7-13/14 will help establish trends in the remaining mass and release rate.

6.2.7 Spreading Area and Big Lost River Tracer Test

The influence of infiltration from the Spreading Areas and Big Lost River on waste migration is not well understood but believed to be important, especially for VOC transport. Operable Unit 7-13/14 is currently conducting a tracer test inside the SDA to better understand the influence of surface infiltration on waste migration. Operable Unit 7-13/14 also has a tracer test planned to help determine the influence of water from the Spreading Areas and Big Lost River. The schedule for the tracer test is governed by water availability and will be conducted when sufficient water exists to fill Spreading Area B. Water availability has been inadequate for the past 3 years, and therefore, any data from the test will not be available for the planned modeling (see Section 6.2.5).

6.2.8 Extent of Low-Permeability Zone in the Snake River Plain Aquifer

A low-permeability zone in the Snake River Plain Aquifer is suspected of having a significant influence on the predicted concentrations of contaminants (Magnuson and Sondrup 1998; see Footnote C). Pump tests on aquifer wells and an ongoing tracer test in the aquifer are necessary to understand the extent and influence of this feature. As OU 7-08 or other projects drill aquifer wells, pump tests should be performed and the data used to better define the zone. Currently, no plans have been made to drill

additional aquifer wells other than a replacement for Well M10S. A tracer test being conducted by OU 7-13/14, where a tracer was added to Well M17S, will also help define the extent and understand the influence of the low-permeability zone.

6.2.9 Volatile Organic Compound Degradation Rate and Mechanism

Strong evidence exists that carbon tetrachloride degradation is occurring and may be a significant process in understanding the fate and transport of the VOCs. However, the degradation mechanism and rate are not well understood. The current plan is to investigate carbon tetrachloride degradation as part of a sensitivity analysis using the VOC transport model. Based on the modeling results, the need for a more comprehensive investigation of degradation will be determined.

7 PROBLEMS ENCOUNTERED AND LESSONS LEARNED

7.1 Organic Contamination in the Vadose Zone Vapor Vacuum Extraction and Treatment Unit C Failure Root Analysis Report

An investigation and root cause failure analysis for VVET Unit C was performed on July 1, 1998. A structural inspection of Unit C revealed the existence of holes in the lower half of the tubes. Mesh at the bottom of the tube sheet, which retains the ceramics inside the tubes, had failed, allowing the ceramics in one tube to fall into the inlet plenum. Missing insulation on the tube sheet was concluded to contribute to the failure.

Following repair, Unit C was restarted on September 19, 1999, and operated until a failure again occurred on May 31, 2000. A failure analysis was performed to determine the cause of the subsequent failure. The results of this analysis are documented in the *Organic Contamination in the Vadose Zone Vapor Vacuum Extraction with Treatment Unit C Damage Report* (Versar 2001). Inspection of the oxidizer revealed that moderate to major high-temperature damage had occurred in each of the 12 feed tubes. Modeling of the system with computational fluid dynamics was initiated to provide further understanding of the failure mechanism. This modeling revealed that failure was caused by the combined effects of excessively rich propane feed, high temperature conditions in the oxidizer at startup, and a system design flaw resulting in uneven distribution of flow to the feed tubes. Based on this conclusion, a management decision was made to decommission Unit C and replace it with the newly procured VVET Unit D (see Section 6.2.1).

7.2 Unit Operations

The operation and maintenance requirements include operations, maintenance and upkeep of equipment, training, reporting, maintenance of a spare parts inventory, calibration, update of drawings and procedures, new equipment procurement, and other activities. As the project moves from the operations phase to the monitoring phase, the Operation and Maintenance Plan will require significant revision to capture the new activities and organizational structure under which they are executed. These details will be documented in the future as the project approaches and enters the compliance verification and long-term monitoring phase.

The following sections were taken from the respective data reports for VVET unit operations. Section 7.2.2 is from *Organic Contamination in the Vadose Zone Environmental and Operational End-Year Data Report, 1999* (Rodriguez 2000a). Section 7.2.3 is from *Organic Contamination in the Vadose Zone Environmental and Operational Mid-Year Data Report 2000* (Rodriguez 2000b). Section 7.2.4 is from *Organic Contamination in the Vadose Zone Environmental and Operational Year-End Data Report, 2000* (McMurtrey 2001a). Section 7.2.5 is from *Operable Unit 7-08, Organic Contamination in the Vadose Zone Environmental and Operational Mid-Year Data Report, 2001* (McMurtrey 2001b). Section 7.2.6 is from *Operable Unit 7-08 Organic Contamination in the Vadose Zone Environmental and Operational End-Year Data Report, 2001* (McMurtrey 2002).

7.2.1 Summary of Operations Activities and Lessons Learned

Several significant lessons were learned through the operation of the VVET systems from July 1999 to January 2002, which enhanced system operations and minimized operational downtime.

Drawing on the previous 5 years of operating history, operating procedures and system drawings were updated to reflect the current system configuration and bring the operation into full compliance with

INEEL work control procedures. This procedure revision heightened the awareness of RWMC facility management about OCVZ operations. As preventive maintenance procedures were developed and implemented, OCVZ became a priority for RWMC craft support, including mechanics, pipe fitters, and electricians. The commitment and support of RWMC facility management and craft support has significantly reduced the operations downtime resulting from planned and unplanned maintenance activities.

By maintaining an inventory of spare parts on site, the response to unplanned equipment failures is greatly improved. Though many critical spare components are stored on site, it is impractical to purchase, store, and maintain spares for all system components. As a result, a configuration management database has been developed that details key information required for purchase of any installed components. This constitutes a reduction in the time required to research information, including part numbers, critical equipment specifications, and vendor contact information. The result is a net reduction in unplanned system downtime resulting from component failure.

Following failure of Unit C on May 31, 2000, modeling of the oxidation process revealed a design flaw that contributed to the failure. It was determined that a similar flaw existed in Units A and B oxidizers but to a lesser extent. Operating procedures were modified to reduce the likelihood of a failure occurring in Units A and B as it had in Unit C. To date, the measures have proven effective in protecting the remaining thermal oxidation systems from catastrophic failure.

7.2.2 End-Year 1999

The rebuilds of Units B and C were completed, and the units were restarted on August 13, 1999, and September 2, 1999, respectively. During the system operability testing of Unit B, it was determined that the propane pressure regulator on the preheater feed line had failed. The regulator was replaced, but ignition attempts were unsuccessful. The igniter was replaced, and the unit was started in preheat mode on August 4. On August 5, an air relief valve failed, and the unit was shutdown by the operator. The electrical coil of the valve was replaced, and system operability testing continued. Unit B was placed into preheat mode on August 11, but it could not achieve its required temperature at the manufacturer's design settings. The propane flow into the unit was increased incrementally until the temperature was achieved. The unit was placed into profile mode but could not maintain temperature at the manufacturer's settings. The propane flow was again incrementally increased, and the unit was placed into operability testing mode on August 13. Of the 3,432 hours available, Unit B operated 2,544 hours for a total uptime of 74%. Approximately 15 days (360 hours) of downtime were attributed to facility-wide electrical shutdowns.

Unit C system operability testing commenced on August 17 with a walkdown of the unit for preparation of the redline as-built drawings. A replacement electrical coil for the XV-211 valve was received and installed on August 26. Unit C system operability testing was completed on September 2, and the unit was placed into operability testing mode. The high alarm airflow setting was adjusted to 360 ft³/minute on September 9. The propane vaporizer blowing out caused the unit shutdown on September 10. On September 19, the unit was placed back into operability testing mode. Of the 3,432 hours available, Unit C operated 2,424 hours for a total uptime of 71%. Approximately 15 days (360 hours) of downtime were attributed to facility-wide electrical shutdowns.

Unit A was down approximately 1 week for replacement of the unit's air compressor. Of the 3,432 hours available, Unit A operated 3,120 hours for a total uptime of 91%. Approximately 15 days (360 hours) of downtime were attributed to facility-wide electrical shutdowns.

7.2.3 Midyear 2000

Unit A shutdown the weekend of December 25, 1999, and was brought back online Monday, January 3, 2000. The low-temperature alarm was recorded as the cause of the shutdown. Unit A went down at approximately 7 a.m., January 10, as the result of high winds knocking out the vaporizer pilot light. Unit A was restarted and put back into operating mode the same morning. Units A and C lost power on Monday, February 14, because a fuse blew at the main power pole. The power supply for Unit B was not affected by the blown fuse; however, Unit B shutdown later the same day because of a storm and resulting power outage at the RWMC. Unit B was brought back into run mode on Tuesday, February 15. After power was fully recovered, Units A and C were restarted and placed into run mode late in the afternoon on March 2. On Thursday, March 30, Unit C failed because of problems associated with the air compressor tank. A crack in the tank was identified as the cause. The compressor tank for Unit C was replaced on May 10. On May 11, a pressure control valve on Unit C failed. Unit C remained down until May 15. Operation of Unit B was interrupted on May 18 because two thermocouples failed. Unit C operations ceased following VVET technician training on Wednesday, May 31, at approximately 10:00 p.m. because of high temperatures in the exhaust stream. Efforts to restart Unit C on June 1 and June 5 were unsuccessful also owing to high temperatures in the exhaust gas stream. Following mechanical inspection, Unit C was determined to have failed catastrophically (see Section 7.1).

Of the 4,032 calendar hours available, Units A, B, and C operated 3,520 hours (87%), 3,236 hours (80%), and 1,938 hours (48%), respectively, during the midyear 2000 operations period.

7.2.4 End-Year 2000

Several mechanical modifications to Units A and B were completed during the FY 2000 shutdown for system maintenance and VOC concentration rebound. Modifications included installing a linear control valve on the ambient air intake, removing the reducing orifice on the ambient air intake, and installing propane flow meters. A preventive maintenance schedule also was developed and implemented. The intent of these changes is to enhance reliability of operations, resulting in decreased downtime in future operating cycles.

A catalytic oxidation system, Unit D, was purchased from King Buck Technology of San Diego, California. This system was tested and demonstrated a destruction and removal efficiency in excess of 99.97% using 200-ppmv carbon tetrachloride spiked into ambient air. The unit is installed at the former Unit C location. The King Buck unit is anticipated to provide a significant increase in operational uptime relative to the Thermatrix oxidizers. Project documents, including safety analysis, test and operating procedures, and a technician qualification program, have been developed.

Of the 3,144 calendar hours available, Units A, B, and C operated 2,325 hours (72%), 0 hours (0%), and 0 hours (0%), respectively, during the end-year 2000 operations period.

7.2.5 Midyear 2001

Few mechanical modifications to Units A and B were completed during midyear 2001 operations. A large effort was undertaken to revise and update standard operating procedures to reflect current system configuration and document requirements. Preventive maintenance activities were completed according to a previously developed preventive maintenance schedule. Several minor system failures occurred and were corrected. Unit D catalytic oxidizer installation and testing was completed during the midyear operations period.

Of 4,008 calendar hours available, Units A and B operated 2,440 hours (61%) and 624 hours (16%), respectively, during the midyear 2001 operations period.

7.2.6 End-Year 2001

Few mechanical modifications to Units A and B were completed during end-year 2001 operations. Preventative maintenance activities were completed in accordance with the OCVZ VVET preventive maintenance schedule (McMurtrey and Harvego 2001). Several minor system failures occurred and were corrected. Unit D catalytic oxidizer installation and testing was completed, and the unit was brought online for the first time during the end-year 2001 operations period.

During the end year 2001 operations period, a goal was set for continuous operation of Units A and B, except for 14 days of planned downtime for execution of semiannual and annual preventive maintenance. A goal of 6 weeks continuous operation of Unit D was set as part of the final acceptance.

Of the 4,080 calendar hours available, Units A and B operated 3,049 hours (75%) and 3,712 hours (91%), respectively, during the end-year 2001 operations period. Unit D shut down because of gasket and heater failures. The goal of 6 weeks continuous operation for Unit D was not achieved during the end year 2001 operations period.

8 OPERABLE UNIT 7-08 REMEDIAL ACTION COST SUMMARY

The first phase of remedial action operations (i.e., Phase I) was initiated in January 1996 and continued through January 1998. In 1998, following a decision by the DOE, EPA, and IDEQ, the remedial action transitioned into the second phase of operations. Phase II remedial action operations and monitoring is continuing to use oxidizer systems to remove and treat organic contaminated vapors from the vadose zone. During the Phase II remedial action, one thermal oxidizer was replaced (i.e., Unit C) by a catalytic oxidation system (i.e., Unit D), and two deep wells were installed inside the SDA (i.e., M17S and DE-1). Additional work planned for Phase II operations includes replacement of the remaining two thermal oxidizers (i.e., Units A and B) and installation of additional extraction and monitoring wells at varying depths. As of December 31, 2001, the total mass of VOCs removed and treated in the oxidizers is 47,280 kg. This total includes 30,326 kg (66,857 lb) of carbon tetrachloride, 6,722 kg (14,819 lb) of trichloroethene, 1,870 kg (4,123 lb) of 1,1,1-trichloroethane, 1,551 kg (3,419 lb) of tetrachloroethene, and 6,811 kg (15,016 lb) of chloroform. Total remedial action costs incurred through December 31, 2001, are shown in Table 8-1.

Table 8-1. Operable Unit 7-08 remedial action costs through December 31, 2001.

Description	Operable Unit 7-08 Project	Operable Unit 7-08 Record of Decision (Estimate) (DOE-ID 1994)
Phase I costs		
Construction (including capital cost)	\$2,200,000	\$3,013,037
Operations and maintenance (including monitoring costs)	\$3,600,000	\$9,842,307
Total Phase I costs	\$5,800,000	\$12,855,344
Phase II costs		
Construction (including capital cost)	\$885,000	\$5,036,479
Operations and maintenance (including monitoring costs)	\$7,895,000	\$16,937,818
Total Phase II costs	\$8,780,000	\$21,974,297
Total Phase III costs	\$0	\$32,356,792
Total costs through December 31, 2001	\$14,580,000	—
	22% of the Record of Decision estimate for completion	
Total		\$67,186,433

9 SCHEDULE FOR CONTINUATION OF PHASE II REMEDIAL ACTION ACTIVITIES

The OU 7-08 remedial action, as described in the OU 7-08 ROD (DOE-ID 1994), is designed to add additional phases, as needed, to ensure the selected remedy achieves remedial action objectives. For cost estimation purposes, an assumption incorporated into the ROD (DOE-ID 1994) was that remedial action would occur in three phases with each phase having a duration of 2 years. The ROD (DOE-ID 1994) stated that the actual duration of each phase would depend on elements, such as equipment procurement and installation, that may be involved with each potential phase transition. In addition, organic waste remaining in the pits could extend the timeframe required to achieve remedial action objectives using the selected remedy because the remaining organic waste could act as a long-term source of organic contamination in the vadose zone. Operations, maintenance, and monitoring for Phase II, the second phase of the remedial action, are expected to continue until active extraction is no longer required to ensure that the remedial action objectives will be met. Project lifecycle planning assumes that the source of the organic contamination will be eliminated or reduced to the point where active extraction within the SDA will not be required beyond 2018. This estimate is based on the following assumptions:

- The OU 7-13/14 ROD will be finalized in 2008.
- The selected remedy for OU 7-13/14 will be implemented in 2010.
- The selected remedy for OU 7-13/14 will reduce or eliminate the source of the organic contamination by 2012.
- Once the source of the organic contamination is reduced or eliminated, no more than 7 years (i.e., 2012–2018) will be required to extract and treat organic vapors remaining in the vadose zone. Monitored vapor concentrations must satisfy the conditions required for shutdown of active extraction (INEEL 2002).

Once the decision has been reached to shut down active extraction, the remedial action will transition into Phase III. During Phase III, a compliance verification period will be initiated. Sampling during the compliance verification phase will provide the information necessary to decide if the system needs to be restarted or if the system can be shutdown, thereby concluding the remedial action and initiating the long-term monitoring phase. The project assumes a minimum of 1 year for compliance verification (i.e., 2019). The long-term monitoring phase is initiated after the remedial action is complete. During the long-term monitoring phase, the VVET systems remain shutdown, and vapor monitoring is conducted at a lower frequency than during operations or compliance verification periods.

10 ENFORCEABLE MILESTONE

The following document has been determined to be an enforceable milestone for the OU 7-08 remedial action. The associated date is for submittal of the draft document to the agencies.

- Draft “Final OU 7-08 Remedial Action Report,” December 15, 2020.

11 REFERENCES

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